TremorWear: A Smart-Sensing, Device-Independent Tremor-Suppression Library for Wearable Tremor Orthoses

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Tremors are a debilitating symptom of common neurological diseases such as Parkinson's and Essential Tremor which affects over 10 million people in the US alone. Currently, non-invasive tremor-suppression orthoses under research development are limited by their inability to calculate precise in-phase suppression signals and calibrated torques for controlled tremor suppression. To address this pressing issue, we developed TremorWear: a device-independent library to be implemented onto tremor-suppression orthoses that filters tremor-induced motions from a tremor patient's voluntary movements and predicts an in-phase actuator response that suppresses tremor-induced motions in real-time. TremorWear is the first device-independent library for tremor orthoses to the best of our knowledge. We designed TremorWear to take motion data from sensors such as IMUs and apply a bandpass filter in the tremor frequency range (3-12hz) to extract only tremor-induced motion. The filtered data is then passed into a deep neural network (CNN-LSTM) which predicts a sequence of future tremor signals in the range of [t,…,t+N?t] to account for processing and actuator response time delays. To train the model, we developed a simulation environment which simulates tremor-induced motion by augmenting real patient data collected at our local hospital. The fully-trained model achieved an average phase error of 5 ms and an average amplitude suppression efficiency of 84.4% when predicting 50ms ahead on sequences of patient data. TremorWear finally converts the model output through a feedback loop into a calibrated torque signal, which an actuator uses to suppress a tremor with solely the necessary counteractive force.

Awards Won:
Second Award of $1,500